MAPS ladder IB + TPC simulations

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Progress since last week

Since I reported last week on first results with a 7 layer ladder maps tracker, I have:

- Updated the evaluator classes to work properly with the ladders
- Re-checked the pixilization and clustering
- Worked on the outer stave spacing to eliminate overlaps

Since then, I have been working on setting up a macro that replaces the cylinder cell MAPS layers with ladders in the MAPS +TPC simulation

Code changes

Implementing the MAPS ladders in the TPC simulation required updates to:

PHG4TPCClusterizer

- Introduced MAPS ladders geometry object
  - Needed to get cluster z and phi bins
- Modified algorithm so that only TPC layers are considered
  - Easiest fix for segfault caused by assumption that all silicon layer geometries are the same

PHG4HoughTransformTPC

- Introduce MAPS ladders geometry object
  - Needed by the tracker to get layer radii and pixel sizes

Macro changes

The setup is created in the macro:
G4_Svtx_maps_ladders+tpc.C

which started out as a copy of
G4_Svtx_maps+tpc.C
in which I replaced the cylinder cell Svtx part with ladders.

I modified my versions of
Fun4All_G4_sPHENIX.C
G4Setup_sPHENIX.C
to make it easy to switch between the two inner barrel models.

Thresholds

The threshold settings in the standard macro:
G4_Svtx_maps+tpc.C
are set using MIP fractions of **0.25** for the cells, and **0.5** for the clusters
I found that this leads to a significant loss of efficiency for both the cylinder cell and ladders cases.

For π^+ tracks in the p_T range 0.5-8.0 GeV/c, with $-0.2 < \eta < 0.2$
(100 tracks, thrown with the same random seed)

With the cylinder cell model the track efficiency is:
78% with 0.25 mips for cell threshold and 0.5 mips for cluster threshold
95% with 0.1 mips for cell and 0.1 mips for cluster thresholds

With ladders, the track efficiency is:
56% with 0.25 mips for cell threshold and 0.5 mips for cluster threshold
91% with 0.1 mips for cell threshold and 0.1 mips for cluster threshold

Therefore I have lowered the cell and cluster thresholds to 0.1 mips

Thickness

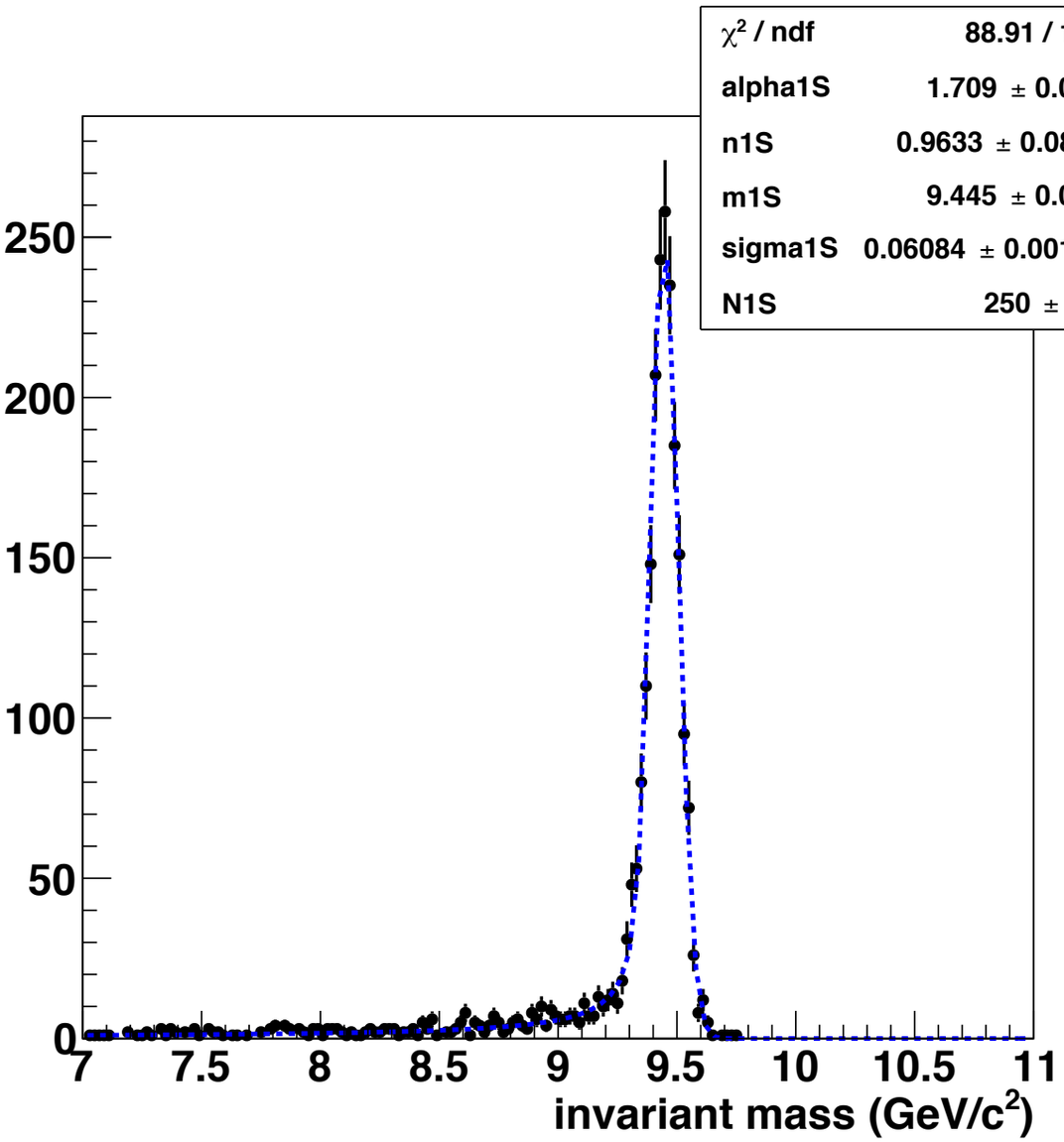
According to the ALICE ITS model, the active sensor thickness is 18 microns. In the cylinder cell model, we are using 50 microns.

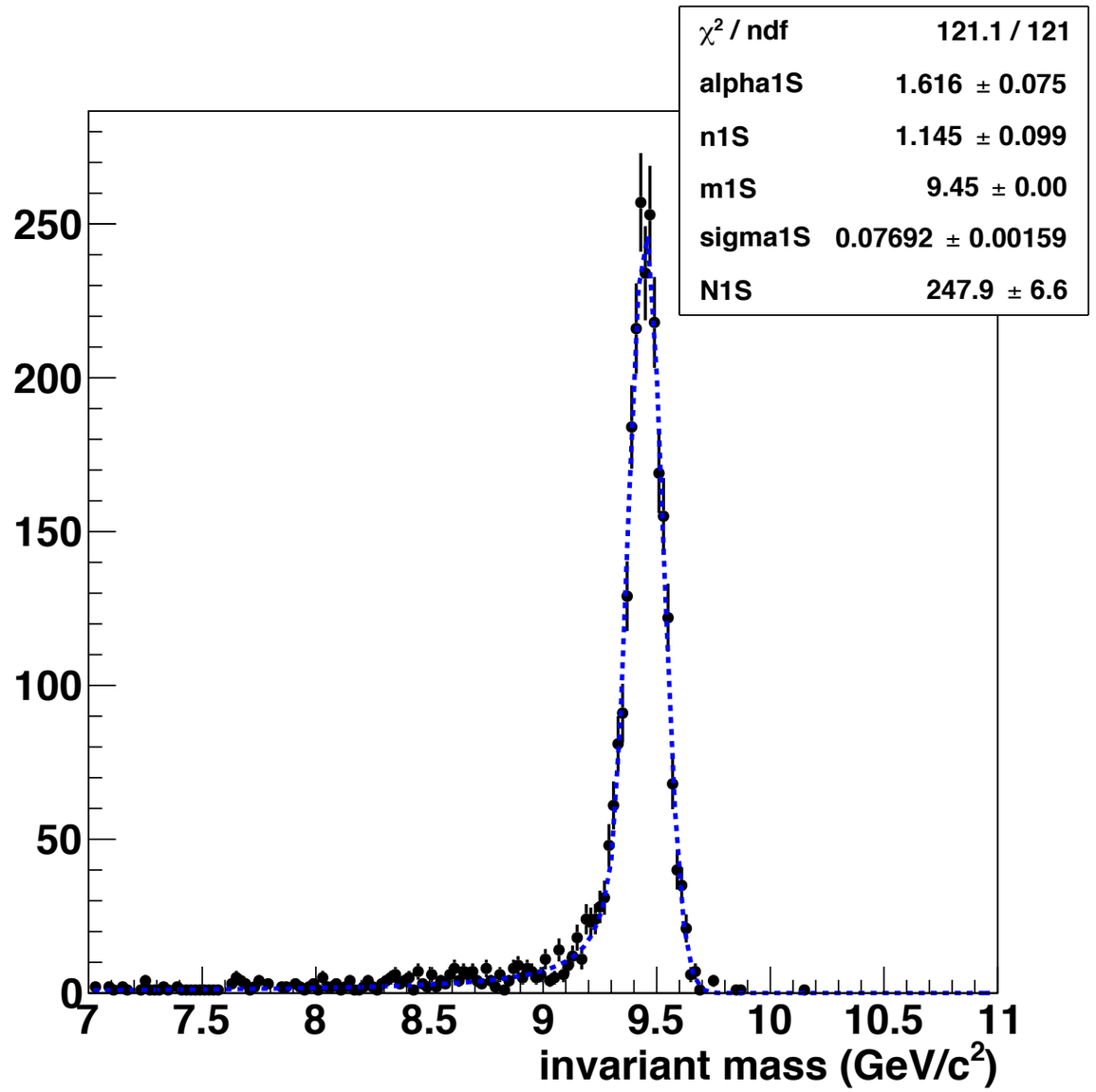
The thresholds are set using a fraction of the mip energy loss in the active thickness, so they should scale to match the thickness. However there may be secondary effects. In any case we should set the thickness in the cylinder cell model to 18 microns.

The smaller thickness leads to lower energy loss in the ladder sensors. Therefore I modified the ADC scale factor in PHG4SvtxDigitizer from 1e-06 to 0.4e-06 - this boosts the digitized ADC values back into the range used in the cylinder cell case.

Results - Upsilon mass spectrum

Comparison of cylinder cell inner barrel and MAPS ladder inner barrel with TPC outer tracker - poorer mass resolution, higher efficiency.





Cylinder cell
61 MeV
efficiency 39%

-1 < η< 1

MAPS ladders
77 MeV
efficiency 48%

To do

Make dca and purity plots for comparison with the cylinder cell maps case.

I have run some condor jobs with pions embedded in Hijing events, but they just finished, and I have not had time to process the output yet.

Code location

The code and macros are in:

https://github.com/adfrawley/coresoftware/tree/ITS_MAPS_development/

https://github.com/adfrawley/macros/tree/ITS_MAPS_development/macros/g4simulations

Macros that are set up to produce the Upsilon spectra are in:

https://github.com/adfrawley/macros/tree/QTG_macros/macros/g4simulations